GAS JOURNAL, MAR. 15, 1944
VOL. 243 96th YEAR No. 4217

EDITORIAL NOTES

BASES FOR SUCCESS

THE story of gas progress in the area covered by the Swindon United Gas Company during the past twelve years is in more ways than one highly interesting. We ourselves have followed this progress closely and have written about it—only a month or two ago we inspected the works and toured the district, subsequently recording our impressions. Naturally in normal circumstances we should have been able to unfold a fuller tale, and there will be more to say after the war. The spirit of confidence which Mr. C. H. Chester has in the future of gas is behind the success he has achieved for all to see—a confidence so positive that those working with him must share it. This confidence is not just a matter of fine words and phrases; it has been the basis of bold policy and practical action, backed by an unusually complete grasp and understanding of the job in hand and the ways and means of getting this job done smoothly and without waste of time. And whatever the ideologies held by the individual concerning gas undertaking organization, everyone must agree that in a period of twelve years of hard and inspired work Mr. Chester has witnessed the achievement of his aims—and a solid achievement it is.

Recently he opened a discussion, opportunely enough, on economics and the gas load at a meeting of the Eastern District of the Southern Association—an enthusiastic body which certainly attracts excellent papers and keen discussions. We published what Mr. Chester had to say in the "JOURNAL" last week and we conclude our report of the meeting on later pages of our issue to-day. We have no intention of going over the ground covered; the points are there for all to study, and we have no doubt they will be studied. Among them is the important question of personnel, in which regard again we come to a further and essential basis on which to build success; indeed, the very workability of any such scheme as that brought to practical issue in the Swindon district hangs on this matter of personnel. We must, as Mr. Chester emphasized, be prepared to pay adequately chief officials and assistants if a high standard of efficiency is to be reached and maintained. It is, of course, an old, old story, but it remains an evergreen problem. Entry must be made more attractive, for we do stand in need of men willing to take reasonable commercial risks after careful planning, and there should be encouragement and backing by live directorates with real directing force and not merely approval. There must be vision and all-round enthusiasm. Mr. Chester has around him a virile and capable team, and he has provided proof of the demand for gas in the rural areas. In his own words, the number of large consumers who are only too eager to take on modern amenities is proof that the Gas Industry has left untapped its rural possibilities simply because it has assessed villages individually, instead of regarding each as providing a link in a chain which might well extend over considerable areas —an aspect of the picture which should be taken into consideration in any future planning of grids for post-war development.

ELECTRICAL UNITY?

A MONTH ago ("JOURNAL" of Feb. 9) we summarized electrical hopes and aspirations concerning the electricity industry after the war, and having reviewed in brief several planning reports, we came to the conclusion that these hopes and aspirations are every bit as diverse as those in the Gas Industry. At the time we made particular reference to a report giving the views of a committee representing more than 90% of the municipal and company distribution undertakings. In point of fact the committee, representative of the Incorporated Municipal Electrical Association, the London Electricity Supply Association, and a group of power companies who are members of the Incorporated Association of Electric Power Companies, was set up at the request of the Minister of Fuel and Power, and the report constituted a parallel to that of the British Gas Federation. It may be recalled that, concerning ownership and organization of existing undertakings, it was recommended that there should be no drastic alteration unless it could be proved that consumers would derive substantial and permanant benefits thereby.

Evidently the London and Home Counties Joint Electricity Authority did not figure in the 90% we have just quoted. The views of this Authority are not at all in accord with those of the "representative" report mentioned. So, to add to general controversy and debate, and to indicate the very real difficulty of marching in step in the absence of powerful compulsion, the Authority has issued its own report criticizing in no uncertain terms its precurser representative one, adding another little puzzle to the maze-like labyrinth of electrical thought. Concerning it, an electrical contemporary speaks of the "battledore-and-shuttlecock procedure now becoming so wearying"; and we ourselves are in sympathy with our contemporary's expression. The procedure certainly is wearying, and it would seem to be almost "established." Anyhow, J.E.A. asserts that the joint memorandum to which we have referred cannot be taken in any real sense as a response to the public demand for a post-war plan for operating the electricity supply service on a national or regional basis. For our own part, we doubt whether the public as such is so keenly interested in the matter, just as we believe that the public is not so concerned as many presumably think with the internal affairs of the Gas Industry—public demand, in brief, boiling down to the desire to have a good supply of gas at a minimum expenditure, leaving the Industry itself (which obviously is the sole channel) to work out how this desideratum can best be met.

By J.E.A. the joint proposals by the company and municipal electrical associations are fairly well damned. "It would," states J.E.A., "be doing a grievous wrong to the public to suggest that they would only accept a national or regional plan to bring an increasingly efficient and helpful electricity service to the whole nation upon the condition that the existing consumers within the area of a local undertaking, already comparatively well served, should receive still further substantial and permanent benefits as compared with residents in adjoining areas." And the report goes on to suggest that the "common danger to their local vested interests," whatever is implied by this "common danger," seems to have enabled the local authority and company groups to join forces in order to preserve their individual and separate entities. The while the transfer of one company undertaking to another company undertaking, however widespread the operation, is apparently not regarded as drastic alteration. The joint memorandum, the representative document, recommended, it will be recalled, co-ordination by area committees. J.E.A. criticizes their proposed constitution on the grounds that it does not include representation of local authorities having statutory purchase rights. It describes the whole memorandum as being depressing in its lack of helpful suggestion. What it wants is public ownership on a regional basis working on a national plan; and, on the question of rural electrification, it goes so far as to suggest an increase in the cost of current to domestic and industrial consumers to meet the capital charge for rural development. And, broadly, it queries whether the views of the "representative" report are in fact shared by local authorities owning electricity undertakings. Frankly, we do not, in reflecting amid the confusion of thought so evident in the Gas Industry, find very much consolation in contemplating the same wearying process in being in the electricity industry; but in all truth the electricity industry does not present a "united front."

Wartime Street Lighting

Though it may be somewhat depressing to contemplate at this stage of the war the installation of new starlight lighting for the future, at least there are grounds for gratification that, to meet demands, the Gas Industry has gone ahead in the matter of development of improved equipment. The equipment to which we refer is the outcome of research at the Watson House Laboratories of the Gas Light and Coke Company, and a description of it appears on another page. To fit in with current conditions in this advanced period of the war the new unit has several interesting features. The allowable output of light is secured with a gas consumption of 0.6–0.7 cu.ft. an hour, compared with 1.6 cu.ft. required with the familiar type of standard fitting. This means a corresponding saving in coal consumption. Again, less metal is needed for its construction, and the man-hours both for producing and installing the new fitting are reduced. It will be noted that a non-aerated burner and a specially designed mantle are employed.

Underground Gasification of Coal

In the British Coal Utilization Research Association's Bi-monthly Bulletin No. 6 Mr. M. W. Thring discusses the subject of underground gasification of coal in relation to the coal measures in Great Britain, and he includes references to and abstracts of published Russian literature. He points out that the fundamental difficulties in underground gasification are clearly how to ensure intimate contact between the gases and reactive carbon before a substantial proportion of the heat liberated by the first reaction has been lost, and how to prevent the short-circuiting of masses of coal by air and gases as the process proceeds. Most British coals, he continues, are worth more per therm in the form of clean sized coal than they would be converted at low efficiency into cold producer-gas of 150 B.Th.U. per cu.ft. obtainable at the pit head. Hence, in spite of the attractiveness of avoiding underground labour and increasing the output per man, the practice of large-scale underground gasification in Britain appears to offer little prospect of proving economical. On the other hand, there are circumstances in which the possibility of piping coal to the surface as gas would merit consideration, provided that coal is gasified and not merely partially carbonized. Such cases might be found where coal occurs in a very thin seam or has a very high ash content (some Russian seams gasified contain 25 to 50% ash), where the seam is steeply inclined, or where the coal has been degraded by underground fires.

Personal

Mr. HAROLD E. BENNET, M.C., Vice-Chairman and London Managing Director of Alder & Mackay, Ltd., has had the distinction of being the first member of the Board to complete twenty-five years as a Director. Mr. J. Miller Thomson presided at an informal luncheon on Feb. 29, and marked the occasion by the presentation to Mr. Bennet of an illuminated address from his colleagues. Congratulations were also extended by Sir Wm. Y. DARLING and Mr. G. I. STEWART, C.A., two of Mr. Bennet's friends who were his comrades in arms in the 9th (Scottish) Division in France in 1914–18.

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When the Newmarket Gas Company held its fiftieth annual general meeting, in the chair was a vigorous young man approaching 80 years of age, Mr. J. H. TROUGHTON, who can claim no small part in the Company's success. He has been present at every one of the fifty meetings in some capacity or other. He first entered the Company as a pupil under his uncle, Mr. Wilkinson, then Engineer and Manager, 62 years ago. In 1882 Mr. Troughton was appointed assistant to Mr. Wilkinson, and in 1890 he succeeded him as Manager and Secretary. He held that position for 45 years, and in 1929 was appointed to the Board of the Company and immediately elected Chairman.

* * *

Mr. HARRY R. WIMHURST is about to retire from the position of Engineer and Manager to the Bury St. Edmunds Gas Company after 29 years' service and having reached retiring age. He has spent over 50 years in the Gas Industry. The Directors have appointed Mr. R. T. THOMAS, Assistant Engineer to the Cambridge Gas Company, to succeed him. Mr. Thomas takes over his new duties early in April.

* * *

Mr. G. FORNACHON, Assistant Gas Engineer at Stourbridge, has been appointed Deputy Gas Engineer at Colne, to succeed Mr. K. Snowdon.

* * *

A Member of The Institution of Gas Engineers serving in the British North Africa Forces has written to the Institution giving information of Mr. FRED BEDFORD, Municipal Gas Engineer at Singapore. Mr. Bedford's many friends in the Gas Industry will be pleased to know that he is alive, but unfortunately is a prisoner-of-war in Japanese hands.

Obituary

The death is announced of Mr. THOMAS SHARRATT GODWIN, who spent the whole of his working life with the Watford and St. Albans Gas Company. He retired from the position of Manager and Engineer of the Watford Works on Dec. 31, 1936. Mr. Godwin was 72 years of age and leaves a widow and two daughters.

* * *

Mr. WILLIAM TOMLIN, J.P., for several years Chairman of Directors of the Isle of Thanet Gas Company, died on Feb. 29, aged 87. He was a member of many public bodies and had devoted most of his life to public work.

Letters to the Editor

Gas Industry Literature

DEAR SIR,—It is evident that Mr. Tomlinson writes with an extensive knowledge of technical literature and particularly that of the Gas Industry, and one feels that his plea for a new Handbook should be taken very seriously. It is indeed somewhat startling to find that a great Industry like ours has really no standard text-book.

The difficulties in the way of the preparation of a suitable book are formidable, but one would think that the first step could be the compilation of a volume of abstracts which would bring together all the properly authenticated knowledge which is available at the present time, but which is scattered over a large number of publications. It is understood that the Gas Research Board has in mind to undertake this task, and it is hoped that a start has been made upon it already. When the first volume is complete it would have to be followed up by the publication, monthly or quarterly, of continuations, constantly bringing it up to date. One would think that once this first step is taken a good deal of the ground will have been covered in the preparation of the standard text-book.

The question of financing the composition, printing, and publication of the book is one for careful consideration. The gas engineer and his assistants need data and technical information every day. One would think, therefore, that the cost should be a charge upon the funds devoted to the development of the Industry as a whole, since the proceeds from sales are not likely to represent more than a comparatively small fraction of the expense entailed.

Riverbank Gas-Works,
Kilmarnock.
March 6, 1944.

Yours faithfully,
ROBERT FIFE,
President, North British Association of Gas Managers.

DEAR SIR,—I am in wholehearted agreement with the views expressed by Mr. T. A. Tomlinson in his article "The Literature of the Gas Industry" which appeared in the March 1 issue of your "JOURNAL," and feel that any suggestion which has in view the provision of adequate technical literature for the Gas Industry should receive very serious consideration.

The framework suggested of an Advisory Committee with Sub-Committees for each subject range editing the work of an individual author appears to be the soundest approach.

It would be useful if apparatus manufacturers could be empanelled on the particular Sub-Committee dealing with gas-works plant manufactured by them, as probably they have more technical and practical information than any other people and, where possible, this should be made available.

The Gas Industry is at a stage of development where considerable changes of policy and technique are more or less imminent, and it is essential that information should be quickly available in a practical way to all concerned.

Abstracts of all technical journals on gas and allied subjects should be circulated monthly, and while it is true that abstracts are already available on Chemical Engineering Plant, Fuels, Gas, Tar, &c., published by the Bureau of Chemical and Physiological Abstracts, &c., these do not give sufficient attention to the technology of the Gas Industry, and contain little about ancillary plant, distribution, or utilization. The publication by the Gas Industry of its own abstracts, and a catalogue of Approved Gas Burning Appliances, on the lines of the London & Counties Coke Association's Coke Burning Appliances Catalogue, are matters which merit consideration.

Further, a really good data book, as suggested by Mr. Tomlinson in his concluding remarks, is urgently required, and the other books suggested by him could follow at a later date.

City of Bradford Gas Department,
Bradford.
March 7, 1944.

Yours faithfully,
GEO. E. CURRIER,
Gas Engineer and Manager.

The Carbonization Process

DEAR SIR,—Several fundamental errors are noted in the recent speech of Mr. J. G. Bennett to the Fuel Luncheon Club. In the first place, he took the average thermal efficiency of a gas-works as 64%, which he later whittled down to 40%. It so happens that 64% represents the efficiency of a group of 12 tiny gas-works each making less than 30 million cu.ft. per annum. Such small works make less than

10%, probably only 5% of the gas made at gas-works. His remarks, therefore, apply only to that proportion of the Industry.

Secondly, he took 10 gallons of tar per ton of coal as representing 4% of the *heat units of the coal*, and also 4% of *the coal substance*. On that basis, the calorific value of the tar and the coal must be the same, whereas tar has a C.V. of over 18,000 B.Th.U. per lb. Further, the 10-gallon figure is too low.

Thirdly, he asserted that we could not say that the chemicals justified the carbonization process. History proves that we *could* maintain the view, as recovery plants were formerly installed free of charge in exchange for the by-products.

Fourthly, he minimized the value of the chemicals by saying that they formed only 1% of the coal. He entirely overlooked the magnitude of the industries based upon this diminutive 1%, such as the antiseptic, dye, plastic, timber and metal protective industries, and so forth.

Finally, his attack on the carbonization industry seems to be inconsistent with the decision of B.C.U.R.A. to embark upon the Fischer-Tropsch system, the basis of which is coal carbonization, and the overall efficiency of which, as far as is definitely known, is only 25%.

Yours faithfully,

"*Oakfield*,"
The Park, Cheltenham,
March 6, 1944.

JOHN ROBERTS.

Diary

Mar. 20.—London and Counties Coke Association: Finance Committee, 11 a.m.; Executive Committee, 11.30 a.m.; Central Committee, 1.30 p.m.; Gas Industry House.

Mar. 21.—B.C.G.A. Publicity Committee: Gas Industry House, 10.30 a.m.

Mar. 21.—Southern Association: Committee, 11.30 a.m.; Luncheon, 1 p.m.; Annual General Meeting, 2.30 p.m. Holborn Restaurant, W.C. 1. Presidential Address of R. C. Taylor, M.B.E.

Mar. 22.—Association of Gas Corporations: General Purposes Committee, at Gas Industry House, 2.30 p.m.

Mar. 25.—Yorkshire Junior Gas Association: Visit to the Neepsend Works of the Sheffield & District Gas Company, 2.45 p.m.

Mar. 25.—Western Junior Gas Association, Bristol: Paper on "High Pressure Storage and Distribution" by B. G. Hawkins.

Mar. 25.—Manchester and District Junior Gas Association: Paper by J. M. Brown on "Steam Production and Use in Gas-Works Practice."

Mar. 27.—B.C.G.A. Domestic Heat Services Committee: Gas Industry House, 2.30 p.m.

Mar. 29.—London and Southern District Junior Gas Association: Gas Industry House.

Mar. 30.—B.C.G.A. Executive Committee: Gas Industry House, 1 p.m., preceded by buffet luncheon at 12.30 p.m.

Mar. 30.—Industrial Gas Centres Committee: Gas Industry House, 10.0 a.m.

Mar. 30.—Midland Counties Coke Association: Annual General Meeting, King Edward House, Birmingham, 2.30 p.m.

April 5.—Southern Association (Eastern District): Gas Industry House, 2.30 p.m. Paper by W. K. Tate, M.A., Assoc. M.Inst.C.E.

April 8.—Scottish Junior Gas Association: Granton Gas-Works, Edinburgh.

April 14.—Manchester District Association of Gas Engineers: Annual Meeting, Midland Hotel, Manchester, 2.30 p.m.

April 29.—Western Junior Gas Association: Exeter. Presidential Address and Annual Meeting.

June 13–14.—Institution of Gas Engineers: Annual Meeting, Edinburgh.

Dividend

Radiation, Ltd.—Dividend for 1943 on Ordinary Stock 10% less income tax at 10s. in the £1. Net income for the year £151,110 (previous year £145,913).

A **Meeting** of the Institute of Fuel and the British Coal Utilization Research Association will be held at the Institution of Electrical Engineers, Savoy Place, W.C. 2, on March 28, when a Symposium of Papers on Underfeed Stokers will be presented and discussed. The purpose of the Symposium is to promote the interchange of knowledge and experience of problems relating to the use of underfeed stokers as applied to furnaces of all types, and to arrange for further collaboration between appliance makers, furnace builders, and users towards the solution of their problems.

The First Session will extend from 10.30 a.m. to 12.30 p.m. The Chair will be taken by Dr. E. W. Smith, C.B.E., President of the Institute of Fuel.

The Second Session, from 2.30 p.m. to 4.30 p.m., will be devoted to the discussion of the Papers presented at the first session, the Chair again being taken by Dr. Smith.

New A.R.P. Street Lighting Unit

A Watson House Development

The Dagenham Borough Council has recently instructed the Gas Light and Coke Company to install some 400 A.R.P. street lighting units. The units, which are of an entirely new design, were developed at Watson House, and are to be manufactured by William Sugg & Co., Ltd., Ranelagh Works, Chapter Street, S.W. 1. The general appearance of the form of the new unit adapted for fitting in square lanterns is shown in fig. 1.

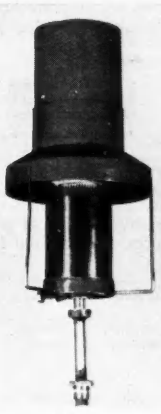


FIG. 1.

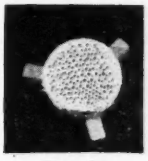


FIG. 2.

The new fitting has been subjected to prolonged trials under practical conditions at Dagenham, and has given satisfaction. The outstanding advantages of the new unit are:

(1) The output and distribution of light specified in B.S. A.R.P. 37 is secured with a gas consumption of from 0.6–0.7 cu.ft./hr., as compared with 1.6 c.ft./hr. required with the familiar type of standard fitting. The use of the usual form of fitting thus involves the processing of approximately 2½ times more coal, and since under existing labour conditions it is not in general possible or economic to light and extinguish A.R.P. fittings each day, the absolute saving of coal consequent upon the use of the new fitting is considerable.

(2) The new unit requires considerably less metal for its construction. It is computed that four of the new units shown in fig. 1 can be made out of the metal required to produce a single unit of the present type.

(3) The man-hours required for both producing and installing the new fitting are reduced.

The above advantages are clearly of moment under war conditions, and help to counterbalance the other increased charges, which would make the older form of unit more expensive to install than was the case when this unit was first introduced.

The following technical points are of interest:

1. The ordinary aerated burner with mantle is unsuitable for gas rates of the order of 0.5–1 cu.ft./hr. in consequence of the difficulty of making small mantles of robust construction, and the expense involved in making bunsen burners with controls, &c., machined to the required accuracy. At these low gas rates the performance of a bunsen burner is liable to be adversely affected by foreign matter carried forward in the gas stream or primary air, which may lead to instability and considerable variation in the total light output from the source.

When in contact with a solid a luminous flame normally deposits carbon on the solid. In the new unit this difficulty has been avoided by using a non-aerated burner having a fine orifice operated at the full service pressure of the gas. The familiar rat-tail burner, which has a non-luminous tip, is allowed to impinge upon a mantle of special design and produce a suitable source of light for A.R.P. and other purposes. Satisfactory results are obtained with the flames directed nearly vertically upwards on to a flat mantle with a slight bulge of 2–3 mm. An illustration of this mantle is shown in fig. 2. The burner in question is made by George Bray & Co., Ltd.

The distance from the burner to the mantle surface is critical, and the construction of the fitting is such as to maintain this distance within the required limits. In practice a 3-hole burner has been found to be most satisfactory. The division of the total gas rate into three ensures that each flame is highly aerated, and that differences of pressure lead to a smaller absolute variation in flame height.

2. The required distribution of light is obtained by surrounding the light source with a glass chimney, upon which has been stencilled (by a process developed by Messrs. Johnson, Matthey & Co., Ltd.) a mask of the necessary design to obscure the unwanted light flux and to control the candlepower in the required directions.

The source of light described is not only applicable to A.R.P. street lighting, but may be used for the illumination of bollards or street signs. It undoubtedly has application in peacetime when a source of low intensity is required.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in the "Journal" should not be taken as an indication that they are necessarily available for export.

GAS-FIRED HOT WATER SUPPLY FOR INDUSTRY

By E. G. BROOKS (Thomas Potterton (Heating Engineers), Ltd.)

THE following is an abstract of a Paper read to the Associate Members' and Graduates' Section of the Institution of Heating and Ventilating Engineers, in which the Author stressed to the heating engineers present the advantages of gas as a fuel and the importance of using it to the best advantage.

For figures on comparative running cost Dr. Oscar Faber's figures given in his Presidential Address to the Institution of Heating and Ventilating Engineers were quoted. These were tabulated as follows:

Cost to Produce One Therm by Various Methods.

System.	Total cost at consumers' premises.	B.Th.U.	Cost per therm of fuel.	Efficiency of use.	Cost per therm of useful heat.
Coke boiler ...	60s. per ton	12,500	2.57d.	50%	5.14
Gas boiler ...	8d. per therm	100,000	8d.	70%	11.5
Electric heater	½d. per unit	3,415	14.6d.	100%	14.6
	1d. per unit	...	29.2d.	100%	29.2

A further set of Dr. Oscar Faber's figures was then presented to prove how, in the interest of national fuel conservation, the use of gas must in future be encouraged. Dr. Faber's figures, summarized in table form, were:

Coal Consumed to Produce One Therm by Various Methods.

	C.V. B.Th.U. per lb.	Efficiency at Works.	Coal to produce one therm (lb.).	Efficiency of use.	Lbs. of coal per useful therm.
Coke boiler ...	12,500	76%	10.5	50%	21
Gas boiler ...	12,500	76%	10.5	70%	15
Electric heater ...	11,500	20%	43.0	100%	43

The Author explained that enquiries for equipment to supply hot water for industry can generally be divided into six classes, which for the purpose of the Paper included only those demands for hot water that were larger than would normally be encountered in domestic hot water supply.

It was suggested that enquiries could be classified as follows:

1. A continuous demand for hot water for a certain period, often at a predetermined temperature.
2. A peak load demand for hot water at regular intervals.
3. A general demand for hot water with peak periods.
4. Two demands for hot water at different temperatures.
5. A bulk of liquid held in a container, to be gradually heated and then maintained at a constant temperature.
6. Boiling water such as for tea or coffee making with either peak or continuous demand.

Each type of enquiry was then given consideration to determine the most suitable plant, as follows:

1. *Continuous demand at a predetermined temperature.*—With this the calculation of the heat input required is elementary—viz., the pounds of water per hour to be heated multiplied by the temperature rise in heating to the desired degree, it being suggested that 40°F. should be used in the calculation for the cold water temperature.

For small continuous demands at comparatively low temperatures, say under 120°F., instantaneous type heaters (or gas geysers) could be used, but thermostatic control could not be provided, the temperature rise being arranged either by a variation of the gas rate or the flow of water through the heater. Open-type geysers were recommended in preference to the closed type, as with the latter the small bore waterways quickly become filled with lime deposit. For large duties or higher temperatures in hard water districts the use of this type of apparatus is not generally recommended, and where the temperature is required to remain constant the plant recommended was a gas-fired boiler with access to the interior for descaling, coupled to a relatively small storage for first heating up prior to the commencement of the process, the storage then being used to form a mixing vessel to even out the small variations of temperature unavoidable with thermostatic control. It was suggested that the storage should be equal to about 20–25% of the hourly output of the boiler. In brief, sufficient boiler power to meet the maximum duty with a small storage (see fig. 1).

It is with this constant type of load, which is often necessary in process work, that considerable economy both in fuel and in the initial cost of the plant can be made by the use of an economizer or heat interchanger.

An example was quoted of a requirement of 10 gallons per minute at 190°F. This would require a boiler plant of 1,000,000 B.Th.U. per hour, and would have a gas consumption of approximately 13 therms per hour.

An economizer to save 70% of the heat, which would otherwise go to waste, may easily be designed, but if only 50% of the waste heat was recovered there would be a saving of 20,000 therms per annum assuming the factory worked a 60-hour week. The method of using the economizer was then described, showing how the hot water from the sprays could be collected and passed through the economizer, the hot dirty water preheating the cold feed to the hot water supply plant, as shown in fig. 2. The essential feature is to obtain contra flow with the hot dirty water and the cold incoming or fresh water.

As is shown in fig. 2, it is possible to get a constant 20° difference in temperature between the two adjacent water surfaces in this way.

From tests, figures of which were given, it was shown that when designing a heat interchanger or economizer there should be as nearly as possible the same amount of water on the outside as on the inside of the heating surface, depth should be allowed for natural stratification of the waters to provide good contra flow, and the heating surface should be as great as possible. The cost of such a heat interchanger, however, would still be less than the cost of the boiler plant it would replace.

Plants have been installed to recover the waste heat from boiling sludge just as effectively as from rinse water.

The second classification was then considered:

2. *A peak demand at regular intervals.*—This provides a simple calculation to determine the load, and, by dividing this load over the hours between the period of demand, to obtain the required boiler output (usually known as the recovery rate of the boiler when quoted by manufacturers in gallons of water heated per hour).

The selected boiler will need to be connected to an insulated storage to hold the bulk of the hot water in readiness for the peak demand. In this way the storage may be very large compared with the output of the boiler, heating up periods of eight hours being quite normal with this type of plant. It is essential to ensure that the insulation

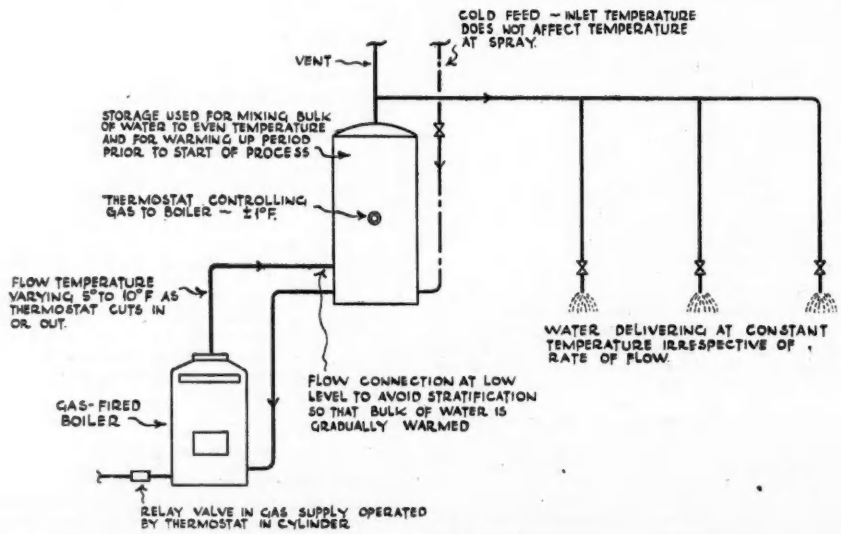

COLD FEED – INLET TEMPERATURE DOES NOT AFFECT TEMPERATURE AT SPRAY.
VENT
STORAGE USED FOR MIXING BULK OF WATER TO EVEN TEMPERATURE AND FOR WARMING UP PERIOD PRIOR TO START OF PROCESS
THERMOSTAT CONTROLLING GAS TO BOILER – ±1°F.
FLOW TEMPERATURE VARYING 5° TO 10°F AS THERMOSTAT CUTS IN OR OUT.
WATER DELIVERING AT CONSTANT TEMPERATURE IRRESPECTIVE OF RATE OF FLOW.
FLOW CONNECTION AT LOW LEVEL TO AVOID STRATIFICATION SO THAT BULK OF WATER IS GRADUALLY WARMED
GAS-FIRED BOILER
RELAY VALVE IN GAS SUPPLY OPERATED BY THERMOSTAT IN CYLINDER

FIG. 1.

of the storage is thorough, and that the boiler has sufficient margin to compensate for this heat loss.

In some process work the volume required may be very large, but the temperature comparatively low, such as 500 gallons at 90°F. every five hours. In such cases it will often be found more suitable to blend the water with cold as it leaves the apparatus, thus reducing the size of the storage. For example, in this case a 250 gallon storage could be heated to 140°F., and mixed with equal parts of water from the cold feed at 40°F. to give the desired result (see fig. 3).

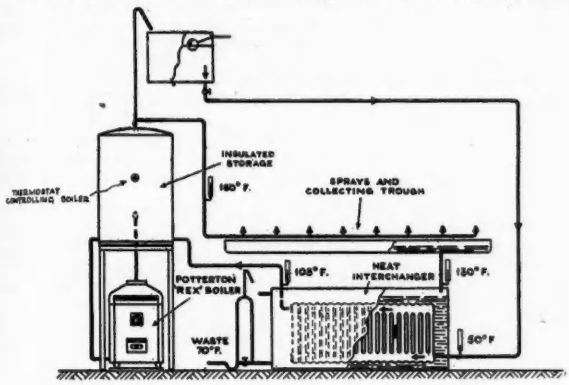


FIG. 2.

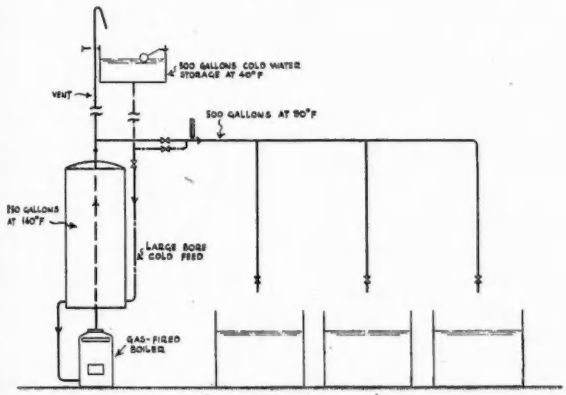


FIG. 3.

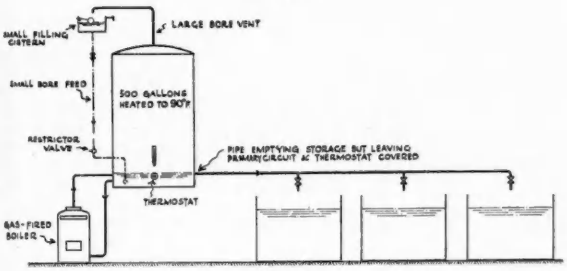


FIG. 4.

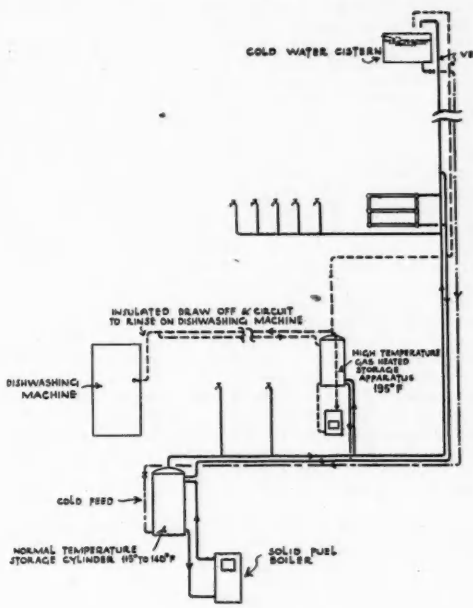

COLD WATER CISTERN
VENTS
INSULATED DRAW OFF & CIRCUIT TO RINSE ON DISHWASHING MACHINE
HIGH TEMPERATURE GAS HEATED STORAGE APPARATUS 195° F
DISHWASHING MACHINE
COLD FEED
NORMAL TEMPERATURE STORAGE CYLINDER 115° TO 140° F
SOLID FUEL BOILER

FIG. 6.

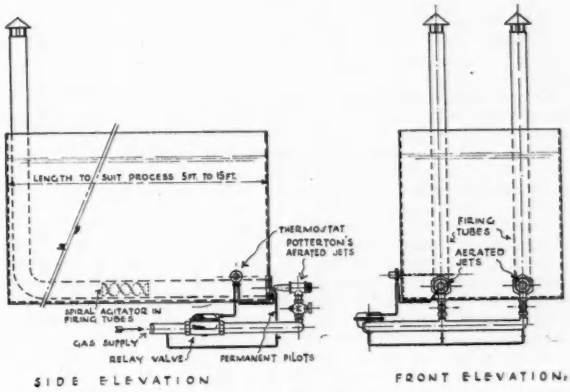


FIG. 7.

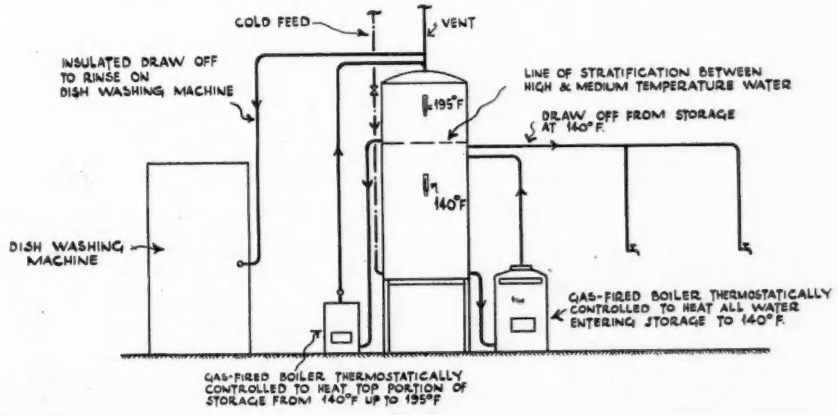

COLD FEED
VENT
INSULATED DRAW OFF TO RINSE ON DISH WASHING MACHINE
LINE OF STRATIFICATION BETWEEN HIGH & MEDIUM TEMPERATURE WATER
195° F
DRAW OFF FROM STORAGE AT 140° F.
140° F
DISH WASHING MACHINE
GAS-FIRED BOILER THERMOSTATICALLY CONTROLLED TO HEAT ALL WATER ENTERING STORAGE TO 140° F.
GAS-FIRED BOILER THERMOSTATICALLY CONTROLLED TO HEAT TOP PORTION OF STORAGE FROM 140° F UP TO 195° F

FIG. 5.

Where the amount of water to be drawn at stated periods is very large, the amount of plant to be supported overhead can often be reduced by installing a comparatively small filling cistern instead of

a large cold-water cistern, as in the previous illustration, and then emptying the hot-water storage into the vat, just sufficient being left in the storage to ensure that the primary connexions from the boiler and the thermostat remain covered.

The cold feed with small bore diameter then allows a trickle supply to refill the storage in time ready for the contents to be heated for the next load. With this type of plant, however, it is impractical to arrange for the blending of the water as in the previous proposal, but very quick filling of the vats can be provided (see fig. 4).

3. *A general demand with peak periods.*—This type of load is the most common enquiry. For example, nearly all works lavatories come under this heading, small quantities of water being wanted throughout the working hours with a very large peak at the meal breaks and at the end of the working day. All that is required in these cases is to calculate the storage for the peak demand, and to ensure that the boiler capacity can heat this during the time between the peaks, and add sufficient margin to deal with the constant load. For works lavatories the demand can vary very considerably according to the type of employee, the conditions under which the employees work, and the amount of equipment which is installed in the form of lavatory basins, washing troughs, &c. Quite useful results can, however, be obtained by providing plant that will supply all the equipment installed continuously for ten minutes at the end of each working period, as employees in a factory will seldom wait longer than this before going to the canteen or their home.

Spray taps delivering about one gallon of warm water, which can be blended to about 95°/100° F., were recommended for hand washing in factories, preventing any risk of spread of industrial disease from one operative to another by contaminated basins; and with taps individually controlled, waste is prevented.

Sprays controlled by foot pedals provide the greatest economy in use of warm water. This foot-pedal type of control is more often encountered with circular wash fountains, but if these are of the type where water flows all the way round the fountain it should only be used for the peak load, individual basins or a trough with a range of spray taps being recommended for the occasional use of the operatives, otherwise waste of water is inevitable, as one person washing at the fountain uses the same amount of water as ten or twelve.

In factories where the work is very dirty, showers and foot baths will be required, and here again foot-pedal control was recommended.

As a guide to the amount of water to be provided in the storage for works lavatories, the following was suggested:

Five Gallons high temperature stored water per person for very dirty work where shower baths, foot baths, and hand washing sprays are provided, if the use of the ablution room is enforced by the Factory Acts.

Three Gallons high temperature stored water per person for very dirty work where shower baths, foot baths, and hand washing sprays are provided, if the use of the ablution room is voluntary.

One Gallon high temperature stored water per person for engineering works where spray taps are provided.

Half-a-Gallon high temperature stored water per person for office or clean workers.

Industrial canteens also provide this type of load, although the steady demand throughout the day is greater.

With canteens it is very bad policy to attempt to fit too small a plant, as the efficiency of the canteen depends so much on there being an ample supply of hot water at a constantly high temperature irrespective of the number of taps in use at one time, this latter point being one of the reasons why storage type heaters are more successful than instantaneous heaters for this class of load. Another point for consideration is the ease of removal of lime deposit, and plant with large bore waterways and of robust construction should be selected. With large loads at high temperature this is very important.

It was pointed out that the amount of water used in a canteen varies considerably, but the following schedule was given, which should prove a useful guide:

Persons per sitting.	No. of sinks.	Size of storage. (Gallons.)	Hourly output of boiler raised 80° F. (Gallons).	Peak output for apparatus in one hour. (Gallons.)
Up to 50	2	34	37	71
50 to 100	3	65	37	102
100 to 200	3	65	56	121
100 to 200	4 or 5	100	56	156
200 to 350	5 or 6	100	112	212
350 to 800	6 or 7	120	123	243
1,000	8 to 12	175	206	381
2,000	12 to 15	200	247	447

4. *Two demands for hot water at different temperatures.*—As found in canteens, where dish washing or bottle washing is carried out mechanically, warm water is used for washing at about 140°F., while water at 195°/200°F. is used for the rinse, sterilizing the equipment and so heating the pieces being washed that upon their removal they quickly dry. Thus, to the plant described under heading 3, a further boiler can be added to superheat a section of the water to the desired degree for the rinse. This water can be stored in the same cylinder. Stratification due to the difference in density combined with the fact that water is a poor conductor of heat prevents the water mixing, so that the two temperatures can be quite easily drawn from the same storage (see fig. 5).

Where hot water is already available, say from a steam calorifier or solid fuel plant, this high temperature water for the rinse can be provided by a gas boiler superheating the water to the desired degree (see fig. 6).

5. *A bulk of liquid held in a container, to be gradually heated and then maintained at a constant temperature for process work.*—For this duty immersion tubes in the base of the container with gas fired through the tubes are usually the most economical method, although for smaller sizes burners underneath the container with the products baffled and carried up the sides of the tank provide efficient apparatus. With the immersion or firing tubes through the tank, insulation can be directly applied to the sides of the tank, and although the efficiency of the tubes may be as low as 60%, the fact that there are no losses between the heat source and the storage provides a high overall efficiency (see fig. 7).

6. *Boiling water such as for tea or coffee making with either peak or continuous demand.*—As the Paper was being read to heating engineers this section was only briefly described, seeing that continuous type and bulk water boilers were available. In the latter cold water is filled into the container, brought to the boil, and drawn off into tea urns, insulated infusers, or teapots, as desired, the water level usually showing on a gauge. For very small canteens there is an interesting combination of bulk water boiler and hot-water apparatus on the market whereby the bulk water boiler is maintained full of warm water by thermostatic control. During the day when no tea-making is required, the hot water can be drawn at the sink in the kitchen merely by being displaced by the cold entering, causing it to run over a weir to the sink in the kitchen. Shortly before the tea break the water inlet is closed and the bulk of water in the storage is brought to the boil ready for tea-making.

Generally.—In the summary the importance of efficient insulation of all gas-fired apparatus was emphasized, simple thermostatic controls were described, and advice was given to heating engineers on the design of suitable flues for carrying away gas products.

The Author also explained that the reason for all the illustrations showing direct hot-water supply boilers connected with a simple primary circuit to the storage, was that with the majority of hot-water loads which are at or below 140°F. the use of thermostatic control prevents over-heating, and thus keeps the lime deposit, which occurs mostly at approximately 160°F., at a reasonable amount collecting in the actual waterways of the boiler, whence it can be removed through the manhole cover provided in this type of appliance. Thus, except in extremely hard water districts, the indirect system is unnecessary.

The advantages of direct hot-water supply are that the boiler can remain at full output from the commencement of the demand until the demand is satisfied, and stratification can be maintained in the storage so that water at correct temperature can be supplied a few minutes after lighting the boiler, even though the remainder of the bulk of water to be heated is still cold.

With indirect hot-water supply bulk heating is substituted, the whole of the storage being gradually warmed degree by degree, and while the heating surface in the calorifier may be sufficient to transmit the full output of the boiler at the start of the heating, unless the calorifier heating surface is very large the output of the boiler is bound to be reduced as the temperature difference between the inner heating surface of the calorifier and the bulk of water approach each other. Obviously for very high temperature water such as 200°F. it is almost impossible to use an indirect cylinder with water to water transmission through the heating surface.

A Great Deal of interest has been shown lately in the "Million Pound Town" situated in Donnington, near Wellington, Shropshire. Ewart & Son, Ltd., have installed many of their "Empire" heaters on this huge estate, which are giving excellent service in the heating of water for bath, basin, and sink.

Accounts for the year ended March 31, 1943, presented at the adjourned ordinary general meeting of George Wilson Gas Meters, Ltd., at Coventry on March 14 showed a profit of £16,549, against £11,004 for the preceding year. Provision had been made for taxation reserve to cover not only the income tax liability up to April 5, 1943, but also the whole of the 1943–44 liability, involving an abnormal appropriation of £13,500. An ordinary dividend of 7½%, less tax, was declared, and £4,826 was carried forward, against £5,027 brought in.

Arising Out of the Meters and Measuring Apparatus Export Group formed in 1940, a new Association has been constituted, known as The British Industrial Measuring and Control Apparatus Manufacturers' Association (the B.I.M.C.A.M. Association), under the Chairmanship of Mr. W. G. Ardley, of Messrs. George Kent, Ltd., with Offices at 21, Tothill Street, London, S.W. 1 (Tel. Whitehall 6711; Secretary, Mr. E. A. Nash). So long as the control of raw materials remains, the Export Group will, of course, continue to function. The membership of the Association, which is confined to established British manufacturers, includes most of the well-known producers of fluid flow meters, industrial measuring instruments, and automatic power and process control systems and equipment. Its objects are to promote the welfare of the industry by the association of its members, and their agreement on matters of mutual concern in research, development, and trading, while retaining all the benefits which accrue from competition within the industry.

ECONOMICS AND THE GAS LOAD

The following discussion, opened by Mr. C. H. **Chester,** took place at a meeting of the Southern Association of Gas Engineers and Managers (Eastern District) on March 1—see last week's "JOURNAL," p. 308.

Mr. **R. C. Taylor** (Torquay), in a written contribution, said he knew from personal experience that when Mr. Chester took over his duties at Swindon 12 years ago he inherited a scrap-heap, but with the greatest determination he had expanded and remodelled the undertaking to its present position. It was now a well balanced and very progressive Company possessing good manufacturing plant and a good distribution system capable of further great progress, which he was sure his enthusiasm and energy would attain. He was very interested in Mr. Chester's experience in connexion with the air filtering system. His own experience with similar plant in his retort house fully confirmed his views. In his own case, with vertical retorts, the coke was de-dusted *in vacuo* before gravitating to the conveyor system. The house was supplied with filtered air, delivered to pre-determined positions, giving considerably better working conditions, the result being contented stokers and good carbonizing conditions. Mr. Chester's free supply and installation of gas coppers to prepayment consumers might appear to be a rather advanced policy. He did not think it was necessary to adopt such a policy in a place like Torquay, but he did suggest that the principle of the averaging of costs would have to be applied more fully in the Industry in the future, rather than the economics of one particular fraction. Mr. Chester was to be congratulated on his progressive and successful enterprise, and a wider knowledge of his work was bound to be of general assistance. Knowing his work in the South-West as Regional Gas Engineering Adviser they could realize to the full that his undertaking had been subjected to the right policy.

Mr. **J. Hunter Rioch** (Cambridge) said there could be little doubt from the results that the bold policy pursued at Swindon had been fully justified. It seemed to him that the consumption per consumer was even now on the low side, but no doubt Mr. Chester would put that right when he resumed his vigorous sales policy after the war. Undertakings would in the future have to pursue a bolder policy with regard to schemes of development, and would have to be content with a lower return to begin with than in the past. There was ample evidence to show that where gas undertakings had laid mains to rural areas the gas sales had risen three- and fourfold within a matter of a few years. He was interested to find that Mr. Chester had kept the average price of gas down to 13.5d., and he hoped he did not propose to reduce it, but rather to use it as a background and introduce tariffs for various purposes. Like Mr. Chester, he had given a great deal of personal attention to the development of a skilled fitting staff. He suggested that they wanted a much higher standard of fitting, as distinct from fitting staff. The fittings one saw up and down the country, put in by so-called up-to-date gas undertakings, were, to say the least, a disgrace, and he hoped they were going to get down to that problem. There were manufacturers at that meeting, and they could make a valuable contribution to the Gas Industry in that direction. He agreed that a higher standard of control of gas-works plant was necessary, and the cost would be well repaid. Side by side with a higher standard of scientific apparatus was the need for more highly trained technical staff. He would make a plea for technical education to be more practical. The practical side of one's vocation should be linked up to a greater extent with the theoretical side. A good deal was being said about higher salaries to attract the right type of young man, but the young man with a University degree must still fall considerably short of requirements even at the age of 25 to 30. Seldom had he developed an ability adequate for the control of staff, and he suggested that great improvement could be effected by putting the young man into touch at an earlier stage in his career with the men with whom he was likely to come into contact at a later stage.

Mr. **Chester,** in reply to the point raised in Mr. Taylor's communication about wash boilers, said he agreed that the policy adopted at Swindon would probably not apply at Torquay. Swindon was in the main a very industrialized town with a large proportion of the poorer type of consumers, the type who did quite a lot of their own washing. They had a limited and fixed income, most of them being railway workers. In peacetime they had a population of roughly 60,000, and 14,000 were employed in one works alone. Taking an average of four persons per family, that left very few for other industries, and it was that type of consumer that he was after. They had cheap coal, and it was his attack on cheap coal that led him to that one point of contact, the wash boiler. With regard to the flat rate, he had had in mind from the beginning, and he had always maintained the idea, that he should keep the flat rate at 1s. He never went below that figure, and he maintained it at 1s. until a matter of 18 months ago. They worked on tariffs for the development of load, and they got their increasing consumption per consumer on that basis. Consumption to-day was low, but Swindon was still an industrial town and they were up against electrical competition, which was quite keen. He thought it was quite a reasonable achievement to have doubled the figure in 12 years, and he hoped it would grow even further after the war. With regard to the technical staff he agreed that there was still a great deal of room for improvement. He had always tried to instil into the junior staff the principle that they should never ask a man to do a job unless they knew they could do that job themselves. He was afraid that young men of 25 from the Universities were reluctant to get down to work in their overalls and see how a machine was put together and taken to pieces, and how everything was working in the gas-works, from the coal entering the retorts to the coke being delivered in the streets.

Mr. **Buist** said he assumed that much of the development described by Mr. Chester had been in new areas, and he wondered if he had had any difficulty in getting hold of sites to put up new holders. On what policy were the developments based? Did they wait for the load to come in, and then lay the mains to meet it, or did they take the bolder line of putting in the mains in the hope that the load would come. He would be interested to know something about the pressures at which they worked, the pressure at the works governor outlet and the pressure they got down to on the district, and to have some idea of the system of high or low pressure distribution. Also, what sort of coal were they using, and how did the price of coal compare with that in London? With regard to fittings, it was good to look for better fittings, but the price should be kept down. The cost of putting in a plug-in point for a poker was very high.

Mr. **Chester** said they had developed a large number of new areas, and they had also developed existing areas very intensively. In the new areas which were canvassed they calculated for an eventual consumption of 75,000 cu.ft. per consumer, and all the mains were built and designed for that capacity. They had added only two new holders on new sites. In about eight cases the storage was increased by putting three or four lift holders into existing masonry tanks. Storage was increased locally to meet peak demands. With regard to the distribution system, the high-pressure mains which left Swindon went in a variety of ways, like the various legs of a spider, all connecting at vital points, and there was a maximum variation of 15/10ths. The maximum pressure was 8 in. and the minimum was 7 in. The price of coal to-day averaged about 47s.; in 1932 the average price was 24s. On the question of poker points, they invariably tried to sell a portable gas fire with every gas poker and they found it an easy proposition. When they took into account the cost of fitting a point it was a very good selling point.

Mr. **E. L. Nicholas** (Guildford) said Mr. Chester's Paper reminded him of the problems with which he was faced at Guildford 21 years ago. There was a large rural area, but the consumption was almost all just within the borough and there were hardly any mains out in the countryside. They had an area of about 50 sq. miles and a number of villages some two, three, and four miles apart. In his early days his Board were reluctant to consider extensions, but by peaceful persuasion he got them to extend to about one village a year. After some years they almost reached the area of a neighbouring undertaking, which agreed to sell to them, and they were then able to take in a lot of territory that had not previously been developed. They found in every village the people were only too willing to take a supply. It meant heavy capital expenditure, but it was well repaid. When they lost practically the whole of their lighting load he looked round for something to make up for it, and over a period of ten years they put in some 600 coppers a year. They were installed free for prepayment consumers, the cost being charged to revenue expenditure for the year, and they had never regretted it. Mr. Chester had mentioned that his Sunday load was still the heaviest, but in the Guildford area the Monday load was nearly 20% higher than the Sunday load by reason of the wash coppers. A lot of them were now due for renewal, but it had not been possible to spend the money.

Mr. **W. A. Barnett** (Mid-Kent) asked what type of main was laid and what was the construction of the joints when Mr. Chester took on the rural districts. His own company were pioneers of high-pressure distribution back in 1909. They distributed gas some 25 miles from the works, and their largest main was 4 in. From the works to their outer districts some 22 to 25 miles away they supplied a thousand consumers direct from the high-pressure main with governors. One thing that had worried him was the large amount of unaccounted-for gas, and it had led him to the question of localizing the villages and putting in high-pressure governors with the idea of keeping the unaccounted-for gas down. They had an acid soil eating the services away, and with gas under high pressure they were losing more than with low pressure. In the early days the company was a water company as well as a gas company, and they thought they could distribute their gas in the same way as water. Instead of applying a solid joint they applied a lead wool joint. They found on opening up that the lead wool was oxidized and there was a great deal of leakage. Wherever possible they were now cutting out the lead wool and putting in a special steel ring and employing electric welding. The long sleeve joint had been in existence for some years, and he would like to know how Mr. Chester had got over his difficulties; whether he had welded steel joints or cast iron mains with flexible joints.

Mr. **Chester** said that in view of the bad soil all his mains were cast iron with a standard flexible joint, and he had found them unfailingly good up to 25 lb. Individual consumers in several thousands of cases were fed direct from the high-pressure mains, with individual governors, although they had several centres of supply in which the gas was governed down to low pressure. Something in the region of 40% of their gas was distributed through the high-pressure system, to individual consumers, to local distributing centres, or to bulk con-

sumers, and their unaccounted-for gas (uncorrected) was not far from 5%. The question of expansion had had to be provided for, and expansion joints had been inserted where necessary.

Dr. **A. E. Haffner** referred to the use of the electric de-tarrer, and asked whether the absence of tar had appreciably led to the elimination of hardened boxes.

Mr. **Chester** said the improvement in regard to the hardening of the purifiers was attributable to the de-tarrer. They could to-day pass 4½ million cu.ft. per day through those same boxes which they could not use at 10 in. less pressure when passing 3½ million cu.ft. two years ago. They found it necessary to keep the moisture content of the oxide correct, and in addition to the dry sealing on the inlet of the boxes they introduced steam during cold weather. The introduction of steam, very carefully controlled, at the proper stage of the revivification cycle had made a vast difference to their purification costs.

Mr. **D. C. Cross** (Lea Bridge) said that Mr. Chester's figures for consumption per consumer showed that he had a very different class of consumer from that in his own area. In his case it was a static area with an average static wage of something under £3 before the war, and 80% of the houses had a rateable value of under £20 a year. Consumers were limited as to the amount they could spend on gas, and the company had been experimenting in many ways to see how they could raise that amount. Some years ago they were losing about 30 consumers a year to electricity because of the black cookers, of which they had 22,000–23,000. The electrical people offered an attractive enamelled cooker, which was particularly attractive to the large number of people who lived in their kitchens with their cookers. They adopted what Mr. Chester had called a bold policy and eliminated the black cookers, and in three years they cleared the whole lot out of the district. It burdened them with an expense of something up to £50,000, but they put it down to suspense account and in due course they found it was well worth it. The modern enamelled cooker stopped the rot right away. Then they set out to encourage consumption by selling apparatus, realizing that they could not increase consumption unless they got the people to have the apparatus. They offered them on very attractive terms spread over five, seven, and even ten years, and they adopted the Gas Light and Coke Company's slogan of a penny a week, or twopence per week, for a piece of apparatus, and it had a marvellous effect. When they put certain apparatus in the showroom window, announcing that it could be purchased at so much per quarter, they effected hardly any sales at all, but when they put out the same apparatus at a penny or twopence per week it caught on, with the result that within a very short time they had put out apparatus worth something like £120,000. The consumer whose income was only £2 15s. or £3 a week could only spend 3s. or 3s. 6d. a week on gas, and if they were encouraged to spend up to 1s. 6d. on apparatus it was difficult to get them to spend an increased amount on the gas they consumed. Consequently there was a time lag. At the outset there was very little increase in consumption, but the time lag had now caught up and they were reaping the advantage. He wondered if Mr. Chester had had a similar experience. The only way he could see, with poorer class consumers, of getting consumption up was to give them an attractive tariff. If their consumption was 20,000 a year and they wanted to raise it to 40,000 they had practically got to give them the 40,000 for the same total cost as the 20,000, and the question was whether the Industry could afford it.

Mr. **Chester** said he realized he could not expect an additional gas consumption unless the additional gas was used to eliminate some other fuel, and it had therefore to be at a competitive rate. To that end a tariff was instituted, calculated on the standing charges, and it was from the tariff that they got their increased consumption. Almost invariably they experienced a time lag until they brought in the five-appliance tariff. The price charged per therm was roughly a fifth of the price per cwt. of coal delivered, and so long as they could keep in that region they could prove that it would pay to use gas appliances. Upwards of 80% of the houses in the district were of low rateable value. It was from that type of property that they had to get their increased load, and the only way was to make the houses more labour-saving. They went out in their policy of canvassing to bring the housewife's work down to a minimum, and the range of appliances was continually brought to their notice. There were people who could not afford to pay 10s. or £1 a quarter, so a scheme was developed whereby the company collected weekly from many thousands of consumers sums of 6d. and 1s. a week. They found that the system of collection facilitated the introduction of further appliances. The additional gas per consumer had in fact reduced the average charge per consumer.

Mr. **McDonald** said it was worth while to consider some of the secrets of Mr. Chester's success. By his personality he had been able to convince his Directors of the soundness of his policy, and they had given him a pretty free hand in developing the district. He had a practical knowledge of every detail of the work, he kept in close touch with it all, and he knew his men well, in fact he believed he knew practically every man in the concern by his Christian name. His staff, like himself, were all young, virile men, and he made their work attractive. He also tried to make the job attractive to the men and get them to take an interest in it. He had done good work in the district by taking an interest in the people and trying to improve their conditions. Reference had been made to overloading of the plant, and in that connexion he deserved great credit. He had seen a number of works recently which had been grossly overloaded. When one found a works having to send out in the middle of summer at least 30% over the load that the plant was designed for, one could see there was little opportunity of doing any repairs. With horizontal retorts, and verticals too, everyone knew how essential it was that repairs should be carried out. There must have been times in Mr. Chester's experience at Swindon when he could not do any summer repairs, and it was marvellous that he had carried on as he had. One item he had mentioned deserved emphasis, and that was the policy of putting in a decent size of service. He thought it was a policy that might well be copied. His exhauster house was a fine example of what an exhauster house should be, and the idea of keeping it under a slight pressure kept up any dust and prevented a great deal of wear and tear of the machinery, besides making it more comfortable and pleasant for everybody.

Mr. **Chester** said this was the first year he had really caught up with his load. They certainly did get horrible peaks, when they had to bring in expensive water gas and to run retort settings in a slightly inefficient manner. He had often taken the bull by the horns and taken great risks, with every bit of available plant working in summer to meet the summer load, while as much as 60% of the main plant had been down for repairs.

Mr. **T. C. Battersby** (Watford and St. Albans) said he was surprised that Mr. Chester had taken 75,000 cu.ft. per consumer as the basis for his calculations. Personally he had found that in the rural areas the consumption per consumer was not so high as in the towns. That was perhaps explained by the fact that the rural worker did not enjoy such a high wage and was able to get wood for his fires, and therefore did not rely on the gas cooker to the same extent as the consumer in the towns. He also went to bed earlier in the evenings. His Company supplied a number of towns and villages through central reducing governors, or from the high-pressure mains. Mr. Chester had mentioned that he had made expansion joints on high-pressure mains. His own Company had laid several miles of high-pressure main and at first they prepared to lay them with expansion joints, but more recently they had laid them without any expansion joints at all, not even for crossing bridges. He was rather surprised that Mr. Chester should have offered any added inducements for winter consumption; he would have thought he would have been more inclined to give some inducement to increase the summer load. Watford and St. Albans installed gas fires at a very cheap rate of 5s. for any amount of pipe work provided the pipe was in the house. Thousands were installed under that arrangement, but they found many people only used the gas fire in extremely cold weather, and they found themselves faced with an abnormal load when they had a sudden frost, and they did not achieve their object of developing a load for the summer evenings. They had been doing similar work with regard to wash boilers, and they were now finding that the wash-day load did not occur on a Monday. So many wives were now out at work that the washing load occurred on Saturday and Sunday; to a large extent it was added to the Sunday morning cooking load.

Mr. **Chester** said there were two reasons why he based his calculations on 75,000 per consumer. The first was a matter of caution, tied up with the capacity of the main and the amount of pressure required to deliver the gas. Within certain limits it paid to put in a large enough main and work at lower pressure, the cost of compression being a factor affecting the cost to the consumer eventually as against the capital cost of the main. The second reason was his faith that within his lifetime they would see smoke abatement becoming a real thing. He had confidence that if we sold gas at the right price we could make a good contribution to smoke abatement; if we could not supply it at the right price we could not expect to get the consumption. The number of electric radiators in his area probably exceeded the number of gas fires. The gas fire load was a weak one, but it was growing rapidly, and for that reason he had offered the special tariff for the two winter quarters. Under the five-appliance scheme, one of the appliances had to be a gas fire in the living-room. Another factor in the winter load was that they had a good coke market, and he wanted to make more coke in winter. The more gas he could make, the more coke he would have for the smokeless fuel market. The two would have to go hand in hand. With regard to expansion joints, they did find them necessary, having installed so much cast iron, particularly with the twists and turns in the country roads, and with the Johnson coupling they got over the problem of the leaky joint. The Johnson coupling had been very satisfactory.

In answer to Mr. **S. E. Knowles** (Eastbourne) Mr. **Chester** said about 18,000 out of a total of just under 30,000 consumers were being supplied with gas under the tariff rates.

Mr. **G. W. Ellis** (Berkhamsted) observed that Mr. Chester's figures for unaccounted-for gas had fallen from 10% to 5%, and asked whether it was progressively dropping, or whether the 5% was regarded as a static figure. If they took 5% unaccounted-for gas from a fuel economy point of view it represented a loss of five tons out of every 100 tons of coal entering the works, and they should all try to reduce the margin of loss. In his own undertaking during the past three or four years the unaccounted-for gas had been about 2½%. Perhaps Mr. Chester could tell them what was his average price per therm to-day.

Mr. **Chester** said his unaccounted-for gas had fallen continuously for some years, but it had been static for the last two years. In considering the figure one had to bear in mind the fact that the gas was

compressed to 25 lb. per sq.in., and it was not dry at the inlet. There was a big correction factor, while the figure quoted was for uncorrected. The true, corrected, figure for unaccounted-for gas was about 2%. The average price per therm to-day was 10.6d.

Mr. **W. H. Bennett** said it would be interesting to know what was covered by overhead costs.

Mr. **Chester** said his overhead costs covered everything outside the manufacturing station, including dividends.

Colonel **Woodall,** proposing a vote of thanks to the Author, recalled that many years ago his father, the late Sir Corbett Woodall, remarked: "Always remember that it pays to spend 2d. per thousand cu.ft. on keeping the works tidy." A truer word was never spoken. In the case of all the works he had had to deal with in designing, and building, and in operation, he had tried very hard to keep them good looking and tidy and clean, and the effect of that upon the workpeople was simply remarkable. The comfort of the workpeople should also be studied. One of the best things ever done in that connexion was at Tottenham, where unsightly dumps of piping and appliances were cleared away and the old-fashioned method of filling dirty tar wagons was eliminated. Flowers, trees, shrubs, and grass added enormously to the beauty of the works. He had a fight with his colleagues on the Bournemouth board once because he wanted to put down some tar macadam on a bit of open space at the Poole works, but he had his way, and the expenditure was more than repaid. People could not be contented at their work if wherever they looked there were dirty corners. He had been interested in Mr. Chester's references to distance distribution. They at Bournemouth laid a long steel main to supply villages in the back districts, and they were also supplying over 24 miles along the sea front from one works, very largely by steel main, and all under pressure, ranging from 10 lb. at the works down to 2 or 3 lb. Both at Bournemouth and Croydon they had abandoned station governors altogether and all the governing was done on the district. He was perfectly certain that maintenance of pressure on the district was one of the main points in securing real distribution. He was sure their output at Bournemouth was due to the fact that there was ample pressure, and the people could get everything they wanted.

Mr. **D. C. Cross,** in seconding, said that given capable engineers, with energy and enthusiasm, unbounded confidence, and a bold policy, the Gas Industry had nothing to fear. Mr. Chester had given them an example of what could be done when those qualities were brought to bear.

BENZOLE RECOVERY BY ACTIVATED CARBON*

By R. WALKER, H. C. APPLEBEE, A.I.C., and A. K. HOWELL,

Manchester Gas Department

(*Continued from p. 310*)

The catch-pot receives all the water condensed in the plant. Any benzole which may be carried into the catch-pot overflows into a separate compartment, from which it can be pumped back to the separator. The water in the catch-pot was formerly pumped to the base of the cooling tower by an electrically driven centrifugal pump, a float in the catch-pot opening a return valve on the pump outlet when the water level falls sufficiently.

The recirculating gas fan is a Bryan-Donkin booster fan, driven by a 4 h.p. turbine drawing off stripped gas from the outlet main and raising the pressure by 4–5 in. W.G.—*i.e*, about 1 in. above the inlet gas pressure, so ensuring that there is excess pressure at the inlet to the adsorber when drying. Hence there is no slip of gas from the inlet of the adsorbing adsorber through the benzole condensers to the drying adsorber.

The water circulating pump is a centrifugal " Mo-pump," driven by a 7½ h.p. turbine. It circulates 15,000 gallons per hour from the bottom of the cooling tower through the benzole condensers and gas cooler (which are all in parallel in the water stream) to the top of the tower.

The cooling tower is of brick, cement-lined, 36 ft. high by 16 ft. square. The main trough at the top distributes the water to six smaller troughs, from which the water drops in streams on to splash plates, which, in turn, throw it off in circular sprays on to the top of the board filling. The water falls down into a 4,000 gall. sump, from which it is picked up again by the pump. The pump suction pipe is fitted with a non-return valve, to avoid the necessity of priming the pump when the plant has been shut down. The forced draught is created by a four-blade " Blimp" propeller, driven by a 12 h.p. electric motor, blowing through a circular hole in one side at the bottom of the tower.

The activated carbon is specially prepared by Messrs. Sutcliffe, Speakman & Co., Ltd., its size being between 12 and 20 mesh.

* From a Paper to the Manchester and District Junior Gas Association.

Starting the Plant

The separator, catch-pot, and cooling tower sump are filled with water, all the gas valves are opened, as are the water valves of the benzole condensers and gas cooler. The steam valves should be closed, except those to steam traps and drains. The main steam valve is then cracked to allow the steam range to warm slowly. After being satisfied that steam traps, joints, &c., are in order, the main steam valve is slowly opened full. The exhaust and drain valves on the turbines are next opened, and the inlet steam valves cracked to clear any water from the system before running the turbines. Lubricators, &c., are checked. When dry steam is blowing from the drains the drain valves are closed, and sufficient steam turned on to allow the turbines to run slowly. The water circulating pump is primed, the inlet and outlet valves opened, and the turbine built up to full speed.

The pet-cocks at the top of the gas cooler are opened to vent any trapped air, and the water-cooling tower is inspected to see that water is coming through.

The motors driving the air compressors and valve gear are started, the air pressure checked, and the relief valves regulated until the air pressure is the same from both compressors (15–20 lb. per sq. in.). The speed control levers on the valve-operating boxes are set in the " stop" position, and the cam-shaft turned by hand to ensure that the automatic gear valves operate. When all have been tested, the indicators on the two cam-shaft boxes are set at right angles to one another, and the speed control levers set to 60 minutes.

The by-pass gas valve is closed slowly to allow the air in the plant to be displaced or discharged to atmosphere, until finally it is fully closed.

The calorific value of the gas should have been raised (by some 35 or 36 B.Th.U.) in anticipation, and engine-men, pressure men, &c., should have had prior warning to expect an increase in pressure as the plant is started.

Gas should be allowed to pass through the carbon for 60 minutes before commencing to steam. During the period the recirculated gas turbine is brought to full speed, the inlet gas valve to the fan being opened sufficiently to give a differential pressure across the fan of 1 in. W.G. more than the differential pressure across the plant.

The low pressure steam valves (from the turbine exhaust main) to each set of adsorbers are opened slowly, while neither adsorber is in the steaming position. This allows any water to drain away before the automatically operated steam valves come into action.

Before the first adsorber is completely steamed, the recirculated gas is warmed up by opening the steam to the gas heater, until the gas temperature reaches 120°–130°F.

The plant works with very little attention except for lubricating valves, turbines, compressors, &c., and occasionally setting one of the two cycle indicators should they get out of phase with each other.

The adsorber shell should be warm when about one-third of the steaming period has elapsed. If it is not, the steam to the adsorbers must be increased either by readjustment of the controls or by loading the high-pressure to low-pressure reducing valve.

Shutting Down the Plant

The normal procedure is as follows: The by-pass gas valve is opened. The two adsorbers which are in the adsorbing stage are steamed and dried before finally closing down, so that all four adsorbers are left ready for use again. After steaming is completed the low-pressure steam valves are closed; and after drying is finished the steam to the gas heater is shut off, the turbine stopped, the water valves on the water circulating pump closed, and the water pump turbine stopped.

Before stopping the compressor motors each adsorber is brought to the "steaming" position, and as the automatic gas valves close, they are pegged in. Lastly, the main steam valve is closed.

Changing the Carbon

When the carbon has deteriorated to such a degree that it is no longer desired to use it, it must be changed. With the existing arrangements this operation is troublesome, and is capable of considerable improvement. In our own case 3 men took 3 days to empty and refill the 4 adsorbers.

The plant is by-passed, and after steaming and drying each adsorber the plant is shut down. The inlet and outlet gas valves are closed as a precaution against possible leaks of the automatic valves. The (24) plates at the top of the adsorbers are removed, and after allowing toxic vapours to disperse, the two emptying plugs on each adsorber are removed. The intention is that the carbon shall fall directly into empty drums, but the drums in our possession were too tall to fit under the emptying holes, so that the carbon had to be run out on to the floor and shovelled into the drums. No provision is made for stopping the flow of carbon once started. The dust made it essential for the men to wear filters over nose and mouth. Some 5 or 6 cwt. remained in each adsorber, as the angle of repose made it impossible for all of the carbon to run out. This residual carbon had to be poked out from the top of the adsorber.

The discharged carbon is sent away for re-activation. The fresh carbon is charged into the adsorbers through the circular holes above the annular ring and well pressed down so as to allow as little settlement as possible. All joints between the adsorber shell and the plates must be made good before bolting down.

With the first batch of carbon 13.7 gall. of benzole were recovered per lb. of carbon, 3.25 gall. per ton of coal carbonized.

The first batch of carbon was in operation nearly seven months. It was then changed, being replaced by fresh activated carbon, the discarded material being reconditioned and returned to us for further use. The actual loss of carbon (by powdering, &c.) was small.

The general circumstances have made it impossible for us to pursue the lines of investigation which we had set for ourselves, and our information is to that extent incomplete. For the same reasons, the inferences to be drawn from the available data are offered with some reserve.

The cycle is lowered progressively, the change being determined by the evidence of "breaking through"—*i.e.*, a sudden rise in the calorific value of the gas at the outlet of the plant. So far as the first batch of carbon is concerned the changes in cycle have been as follows:

Days worked.	Cycle (mins.).
37	120
61	80
21	60
8	48
17	40
6	30
150	

The details recorded in our works books show that as the period is shortened, after an initial increase the recovery of benzole falls again, the net result being a lower over-all recovery:

		Crude Benzole Recovered (Gallons).			
Ref.	Cycle (mins.).	Per ton.	Average.	Per cycle.	Average.
A	120	4.22		46.1	
B	120	4.07	3.92	45.2	42.3
C	120	3.92		40.6	
D	120	3.43		38.7	
E	80	3.45		26.5	
F	80	3.34	3.42	25.3	25.0
G	80	3.46		23.2	
H	60	3.18	2.98	16.6	15.7
I	60	2.78		14.5	
J	40	2.65	2.43	7.1	7.1
K	40	2.24		7.1	
L	120	3.80	3.80	36.0	36.0
M	80	3.14	3.14	25.9	25.9

These figures are given independently of any consideration of the economic results of the shortening cycles. While the increased life of the carbon means lower carbon cost per gallon of benzole, it also entails a lower recovery of benzole per ton of coal. In our own case the course taken was adopted for two reasons: (i) the desire to obtain as full information as possible respecting the activity of the carbon, and (ii) the fact that in the prevailing circumstances we could not in any case extract more benzole from the gas without adding to the difficulties of manufacture and supply.

The lower yield of benzole with the progressive ageing of the carbon is reflected also in the following tests, which indicate, as would be expected, a fall in the percentage of light material recovered.

		N.B.A. Test.		
Date.	Sp. Gr.	% at 100°C.	% at 160°C.	Remarks.
Apr., 1943	0.808	63	92	First batch of carbon.
July, ,,	0.827	58	90	,, ,,
Aug., ,,	0.831	53	87	,, ,,
Sept., ,,	0.830	51	89	,, ,,
Oct., ,,	0.823	55	89	Part 1st and part 2nd batch.
Nov., ,,	0.821	61	91.5	Second batch of carbon.
Dec., ,,	0.824	60	91	,, ,,

In passing we may mention that the sulphur content of the benzole has been between 1.2 and 1.4% by wt., and so falls in Grade C of the N.B.A. classification. Of the total sulphur, about 0.9–1.0% has been carbon-bisulphide, the remainder being thiophene, &c.

Taking the two extreme examples in the above table—*i.e.*, April and September—the N.B.A. valuations are 15.70d. and 15.50d. per gallon of crude benzole respectively. (The average valuation for all the material sold has been 15.67d. per gallon.)

Hence, if the saving in the cost of carbon were greater than approximately 0.20d. per gallon, it would appear to be profitable to prolong the life of the carbon. The net difference, however, does not in any case appear to be very great. There are, of course, other methods of limiting the extraction of benzole from the gas, such as reduced steaming, and we are at the moment assisting in investigating the results of such a course on the toluene recovery in particular. On the other hand, high recovery could be maintained by earlier changing of the carbon.

Whether it is sounder policy to practise partial extraction as against complete is outside the scope of this Paper, and will not be discussed here.

Operating Costs (6 months ended Sept. 30, 1943).

	Per gallon of benzole produced (pence).
Carbon	0.501*
Process wages	0.359
Steam	1.067
Electricity	0.149
Water	0.027
Repairs and maintenance	0.049
Sundry charges	0.024
Salaries, wages, insurance, &c.	0.059
Provision for renewals	0.034
	2.269

* If the carbon were charged at replacement price only and calculated to cover the full recovery of benzole before discarding, this figure becomes 0.272d. and the total cost of production 2.040d. per gallon. This figure is very little different from the cost per gallon of the benzole produced by the old oil plant.

The revenue from the plant during the 6 months ended Sept. 30, 1943, was £6,800.

Effect on Calorific Value

The fall in calorific value due to benzole extraction is shown in the following table, the results conforming very closely to the calculated figures:

Reference.	A	B	C	D	E	F
Recovery (gall./ton) ...	4.22	4.07	3.92	3.43	3.45	3.34
Fall in cal. val. B.Th.U. ...	33	28	28	27	27	25
Reference.	**G**	**H**	**I**	**K**	**L**	**M**
Recovery (gall./ton) ...	3.46	3.18	2.65	2.24	3.80	3.14
Fall in cal. val. B.Th.U. ...	25.5	24	23	16	28	22

In the operation of the plant it has been essential to maintain the calorific value of the outlet gas at the declared value. This has necessitated adjustment of the working of the retort house accordingly. For reasons which are not germane to this Paper, it has not been practicable to increase the throughput of coal to any great extent, and consequently there has been a reduction in the volume of the gas made. This reduction may be inferred from a knowledge of the makes during those periods when the benzole plant was or was not in operation.

It may be taken that the reduction in the volume of gas made has been in the order of 2,000 cu.ft. per ton of coal carbonized when the activated carbon plant was fully working, but, naturally, varying with retort house conditions. It was just this reduction in make of gas which made necessary the intermittent working of the benzole plant, and the same necessity would have arisen whatever the type of benzole recovery plant.

Sulphur Compounds in the Gas

Changes in the quality of the coal carbonized have produced marked variations in the quantity of sulphur compounds present in the gas, but the general effects of the operation of the activated carbon plant are clear.

With the first batch of carbon the reduction in sulphur compounds was at first as high as 63% (from 25.94 grains/100 cu.ft. at the inlet to 9.66 grains at the outlet). As the carbon aged the reduction appeared to remain fairly constant for some time at about 50% (*e.g.*, 22.50 to 11.70 grains), but ultimately it fell to as low as 40%, or on occasion even lower.

The second batch of carbon is behaving similarly, the reduction with fresh carbon being 64% (from 33.39 to 11.91 grains per 100 cu.ft.), while the same order of fall in reduction is at present evident.

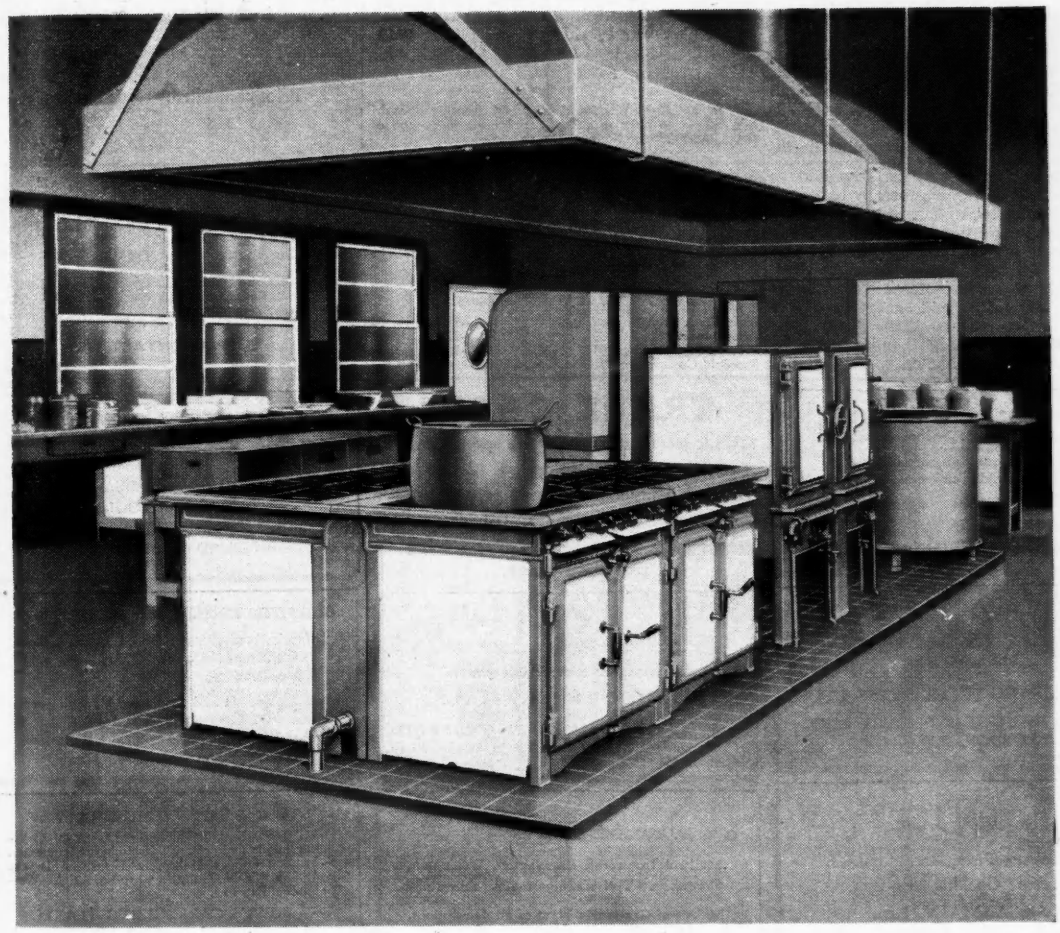
The possibility having been suggested that H_2S might be produced in the adsorbers, tests were made at the instigation of and in co-operation with Mr. H. H. Thomas and Mr. A. Ormrod (of the Liverpool Gas Company). It was found that the formation of H_2S was extremely doubtful, and that even if at all the quantity was extremely small, the total at both inlet and outlet being only of the order of 0.02 to 0.04 parts per million.

Although we ourselves make a practice of keeping the Referees' H_2S test apparatus continually running, we have never had the slightest indication that H_2S was being produced in the plant.

The plant has satisfactorily removed the naphthalene from the gas without difficulty. (The naphthalene content of the Rochdale Road gas is only 3 to 4 grains/100 cu.ft.) If, however, the plant is by-passed either partially or completely, naphthalene inevitably passes forward with the gas, unless independent arrangements are made to prevent it from doing so. We propose at Rochdale Road to erect a small supplementary oil scrubber for the removal of naphthalene at such times as it may be necessary.

(*To be concluded*)

—here are two more examples of Canteen Installations supplied by Radiation Ltd



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GAS PRODUCTS PRICES—STOCKS AND SHARES

The London Market Mar. 13.

A new Government Order came into effect on March 1 controlling the price of Benzole and Coal Spirit and replacing the Control of Coal Tar Naphtha and Xylole Order, 1943.

The new Order is known as the Control of Benzole and Coal Spirit Order, 1944 (S.R. & O. 1944, No. 172).

By this new Order the price of Motor Benzole is fixed at 2s. per gallon. The new Order also lays down the method of evaluating Crude Benzole.

The Order also calls for periodical returns to the Ministry of Fuel and Power from all producers of Crude and Refined Benzole.

The only item of interest to report in connection with the Coal Tar products market is the issue of Government Order designated the Control of Toluene (No. 4) Order, 1944 (S. R. & O. 1944, No. 170), which contains an amendment of the Control of Toluene (No. 3) Order, 1943.

Prices of Coal Tar products are unchanged.

The Provinces Mar. 13.

The average prices of gas-works products during the week were: Pitch and Crude Tar,* Toluole, naked, North, 90's, 1s. 11d. to 2s. 1d., pure, 2s. 7½d. (controlled by the Control of Toluene No. 3 Order, dated July 14, 1943, operative from July 20, 1943). Benzole and Coal Spirit, also Coal Tar Naphtha and Xylole, are now controlled by the Control of Benzole and Coal Spirit Order, 1944, dated Feb. 18, 1944, S. R. & O. 1944, No. 271, operative from March 1. Carbolic acid, 60's, naphthalene, anthracene, creosote oil (hydrogenation), coal tar oils (timber preservation, &c.), and strained anthracene oil controlled by the Coal Tar Products Prices Order, 1943, dated Oct. 20, 1943 (S. R. & O. 1943, No. 1528), operative from Nov. 15, 1943.

* In regard to pitch and crude tar prices we would ask readers to refer to the editorial note on p. 396 of the "JOURNAL" for Sept. 10, 1941.

Scotland Mar. 11.

Tar Acids are more p'entiful but conditions generally are unchanged.

Refined tar*: Yield to Distillers is 4½d. per gallon *ex* Works, naked. Creosote oil: Timber preserving quality,* 5½d. to 6½d.; hydrogenation oil,* 5⅞d.; low gravity or virgin oil,† 7½d. to 7½d.; benzole absorbing oil,* 6½d. to 8d. per gallon. Refined cresylic acid* is 3s. 6d. to 4s. 6d. per gallon *ex* Works, naked, according to quality. Crude naphtha†: 6½d. to 7d. per gallon. Solvent naphtha*: Basic prices delivered in bulk, 90/160 grade, 2s. 8d., and 90/190 Heavy naphtha, Unrectified, 1s. 10½d.; Rectified, 2s. 3d. per gallon. Pyridine†: 90/160 grade, 13s., and 90/140 grade, 15s. per gallon.

* Price controlled. † Uncontrolled.

Stock Markets can only be described as patchy, although the tone generally remained firm. Some gains took place in the gilt-edged market, and selective support was in evidence among industrials, but among others home rails and the colliery group weakened.

Although there was no increase in the volume of business, gas stocks and shares showed a few more improvements than during the previous week. Gas Light units were in demand and closed 9d. higher, while Colonial 8% Preference hardened to 17s. 6d. A feature was the gain of 5s. in Cape Town Preference, the shares changing hands up to 69s.

The following is the full list of price changes during the week:

PROVINCIAL EXCHANGES

Bath Cons. (*x.d.*)	110—112	Feb. 28
Bristol max.	116—118	+1
Newcastle 4 p.c. Pref.	100—102	+1
Sheffield Cons. (*x.d.*)	137—140	Feb. 28

OFFICIAL LIST

Alliance & Dublin	102—112	−3
Brighton Cons.	92—97	+2
Cape Town 4½ p.c. Cum. Pref. ...	55/—75/−	+5/−
Colonial Gas Association 8 p.c. Pref.	15/—20/−	+1/3d.
Commercial Ord.	58—63	+3½
Gas Light & Coke Units	19/3—20/3	+−/9d.
Ditto 3½ p.c. Red. Deb. (*x.d.*) ...	95—98	Mar. 6
South Metropolitan Ord.	81—84	+2

SUPPLEMENTARY LIST

Reading 4 p.c. Deb.	95—100	+1

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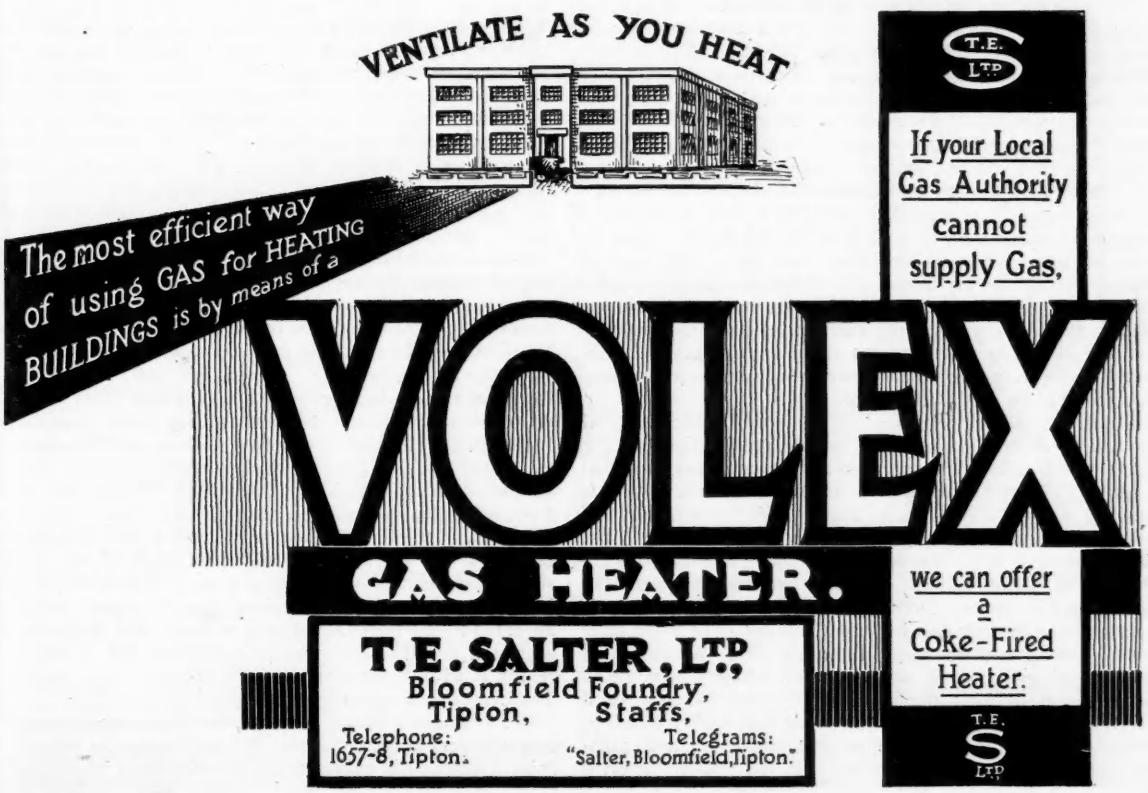
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